

STUDENT PAPERS

After the 4th annual SCAMC in November 1980, the President of SCAMC, Inc., Dr. Rosalie A. Dunn, established a Scholarship/Awards Committee with the charge to establish a student activity for the annual SCAMC conferences. After some deliberations, the Scholarship/Awards Committee proposed a national student paper competition consisting of two phases. In the first phase, the submitted manuscripts are evaluated and ten finalists are selected and invited to the conference. In the second phase, the finalists will present their work at a special session during the 5th SCAMC conference. The top three finalists of the combined written and oral competition will receive cash prizes in the amount of \$1,000.00, \$600.00, and \$400.00 respectively. In order to equalize the travel expenditure for the finalists, the Symposium will pay the travel expenses of the finalists (not to exceed \$800.00). This proposal was later approved and funded by the Board of Directors with the provision that the review and the evaluation be done by a panel of independent reviewers.

Although the announcement of the SCAMC Student Paper Competition was distributed rather late, the response by the students to it was enthusiastic and surprisingly large. By July 1981, over 130 students had written us indicating their intent to participate in the competition. The responses came not only from the North American continent but also from Europe, South America, and Asia. This worldwide response may be a surprise but is an indication that Medical Informatics is becoming an internationally recognized discipline in its own right. As the deadline for the submission of papers arrived, the number of participants dropped to 41. The panel of seven independent experts evaluated and ranked the manuscripts in order of their own priorities and judgments. In general, the manuscripts were evaluated according to their originality, significance, problem statement, methodology, and style. The abstracts or introductions of the papers of the finalists are listed below.

The participants of the student paper competition may be categorized in various ways. On a regional basis, the students came from all over the U.S. representing 16 states (PA, CA, WI, MO, NY, CT, IA, VA, DC, OK, MN, MI, MD, SD, SC, and MA), two papers were submitted from Canada, and one paper each from Israel, the Peoples Republic of China, Belgium, and Brazil. Some of the foreign students attended U.S. schools in 1981. In terms of educational background, we received papers from eight physicians, five were in a residency training program, and three were Ph.D. candidates in Computer Science. The remaining 33 participants had no advance degrees but most of them had some prior computer experience. From this group, 12 were medical students, 15 were Ph.D. candidates in

Computer Science, Biomedical Engineering, or other engineering discipline, one J.D. candidate, 5 master degree students (3 M.S. and 2 M.B.A.), and one student just graduating from highschool entering college this Fall.

The definition of a student was deliberately chosen very broad in order to open the door to all students who use computers in medicine and related health care fields. The only requirement was that the students were enrolled in a degree granting program of an accredited college or university or be a resident in an accredited medical specialty training program during the 1981 calendar year. Medical residents who have already earned their doctorate (M.D. degree) were deliberately included to promote and stimulate the participation of these young physicians in Medical Informatics. However, in the future a more restrictive definition of allowable background must be made.

We hope the student paper competition will heighten the awareness of the field of Medical Informatics and focus the power of computing technology on issues that are important to medicine and the health care system of our nation.

I would like to thank the reviewers for their enormous effort in reviewing and evaluating the manuscripts in a rather short time, the Board of Directors of SCAMC, Inc. for providing funds to this project, the Steering and Program Committee of this 5th SCAMC conference for their cooperation, Mrs. Joan Hullander of the Office of Academic Computer Services at GWU-Medical Center for her unending support, and last but not least all of the students who have devoted energy and time to participate in this competition. Best wishes to all participating students for a successful career in Medical Informatics.

Helmuth F. Orthner, Ph.D., Coordinator
Student Paper and Awards Competition

Review Panel:

Lionel M. Bernstein, M.D., Ph.D., Director
Lister Hill Center, NLM, Bethesda, MD
Howard L. Bleich, M.D., Associate Professor
Harvard Medical School
Charles Heisterkamp, III, M.D., F.A.C.S.
Hogg & Heisterkamp Surg. Ass., Lancaster, PA
H. K. Huang, D.Sc., Associate Professor
BME Program, The University of Iowa
John W. Lewis, Ph.D., Director
M/MIS, Virginia Mason Med. Ctr., Seattle, WA
Howard Moraff, Ph.D., Director
Vet. Med. Comp. Fac., Cornell University
William S. Yamamoto, M.D., Professor and Chairman
Dept. of Clin. Engineering, GW University

AUTOMATED ACQUISITION OF MEDICAL KNOWLEDGE
FROM A TIME-ORIENTED CLINICAL DATABASE:
THE RX PROJECT

Robert L. Blum
Stanford University Department of Computer Science

The objective of the methods and computer implementation presented here are 1) to automate the process of hypothesis generation and exploratory analysis of data in large non-randomized, time-oriented clinical databases, 2) to provide knowledgeable assistance in performing studies on large databases, and 3) to increase the validity of medical knowledge derived from non-protocol data.

The RX computer program consists of a knowledge base (KB), a Discovery Module, a Study Module, and a clinical database. Utilizing techniques from the field of artificial intelligence, the KB contains medical and statistical knowledge hierarchically organized, and is used to assist in the discovery and study of new hypotheses. Confirmed results from the database are automatically encoded into the KB. The Discovery Module uses lagged, nonparametric correlations to generate hypotheses. These are then studied in detail by the Study Module, which automatically determines confounding variables and methods for controlling their influence. The Study Module selects a study design and statistical method based on knowledge of confounders and their distribution in the database. Most studies have used a longitudinal design involving a multiple regression model applied to individual patient records. Data for system development was obtained from the American Rheumatism Association Medical Information System.

Advisor: Gio C. M. Wiederhold, Ph.D.
Department of Computer Science
Stanford University
Stanford, CA 94305

APPLICATION OF BRAIN ELECTRICAL ACTIVITY MAPPING
TO THE EVALUATION OF PATIENTS DURING GENERAL ANESTHESIA

Christopher B. Brooks
Georgetown University School of Medicine
Michel Dubois and Thomas Macnamara
Department of Anesthesiology, Clinical Center, NIH
Richard Coppola
Laboratory of Psychology and Psychopathology, NIMH

Assessing the status of the brain electrical activity of patients during general anesthesia has long been of interest for the anesthesiologist. Specific effects of anesthetic drugs have been recorded and analysed, usually by individuals with a high degree of expertise in electroencephalographic techniques. A system is described that provides computer-generated brain electrical activity maps with both topographic and quantitative detail. Two-dimensional brain surface maps display the data in concise and summarised form, replicate and enhance data obtained using the conventional electroencephalogram under specific anesthetic conditions. This system is simple, explicit, flexible, and accurate, and can provide the researcher or clinician with a dynamic picture of the brain's electrical activity in many applications, in operating rooms, intensive care units, or any situation requiring precise and readily understandable assessment of the effects of drug administration.

Advisor: Michel Dubois, M.D.
Department of Anesthesiology
Clinical Center, NIH

USE OF COMPUTERIZED PSYCHIATRIC DIAGNOSIS
FOR CASE REVIEW

Henry A. Doenlen, M.D.
Department of Psychiatry and Human Behavior, Thomas Jefferson University
Thomas J. Craig, M.D., M.P.H.
Rockland Research Institute

Discriminant function analysis can be used to predict psychiatric diagnosis from a set of patient problems and diagnosis. As such, the discriminant functions represent the aggregate diagnostic criteria of the clinicians who made the diagnosis. Cases identified with discordance between the clinician and predicted diagnosis can be reviewed as part of a quality assurance program. This paper describes a use of discriminant function analysis with a minimal amount of easily and routinely collected admission data to predict diagnosis and identify discordant cases. Potential uses of this method for quality assurance, education and improvement of patient care are discussed.

Advisor: Thomas J. Craig, M.D., M.P.H.
Research Psychiatrist
Information Sciences Division
Rockland Research Institute
Orangeburg, NY 10956

LOCALIZE:
COMPUTER-ASSISTED LOCALIZATION OF
PERIPHERAL NERVOUS SYSTEM LESIONS

Michael B. First, Bruce J. Weiner, and Sean McLinden
Decision Systems Laboratory
University of Pittsburgh School of Medicine

A computer program, LOCALIZE, has been developed to perform localization of lesions in the peripheral nervous system. It uses a knowledge base modelled after the connectivity relationships in the human nervous system. It accepts clinical and electromyographic abnormalities of specific muscles as input, and provides localization of single or multiple lesions accounting for these abnormalities.

Advisor: Randolph A. Miller, M.D.
Decision Systems Laboratory
University of Pittsburgh School of Medicine
Pittsburgh, PA 15261

QRS DETECTION USING AUTOMATA THEORY
IN A BATTERY-POWERED MICROPROCESSOR SYSTEM

Gregory S. Furno and Willis J. Tompkins
Department of Electrical and Computer Engineering
University of Wisconsin-Madison

Portable arrhythmia monitors require accurate and reliable QRS detectors to avoid false alarms. We have devised a software QRS detection algorithm that relies upon basic concepts drawn from automata theory to identify normal and ectopic beats by shape alone and have implemented it in low-power hardware built around a CMOS microprocessor. Our detector rejects many types of motion artifact and electrical noise while distinguishing between normal and ectopic beats. We compare its performance with a typical hardware QRS detector.

Advisor: Willis J. Tompkins, Ph.D.
Department of Electrical and Computer Engineering
University of Wisconsin-Madison
Madison, WI 53706

COMPUTERIZED IMPEDANCE TOMOGRAPHY

Yongmin Kim, Willis J. Tompkins, and John G. Webster
Department of Electrical and Computer Engineering
University of Wisconsin-Madison

Conventional techniques for forming images of the structure within the body use 1) x-rays, 2) radio-isotopes, and 3) ultrasound. X-ray photographic (radiographic) techniques are most used and usually result in frontal and sagittal plane images. Recently, the computerized tomographic (CT) scanner was developed to reconstruct a fine-detail transverse plane image based on the x-ray absorption characteristics in the plane. However, x-rays are ionizing radiation and are harmful to the patient. Tissue damage increases with repeated usage. X-ray exposure should be minimized for pregnant women and children. Also, some body structures such as the lungs cannot be imaged well due to low x-ray absorption.

Ultrasound is a widely used non-destructive technique. Advantages are that it can outline some organs that cannot be imaged by x-rays and it does not pose any hazard to the patient. Ultrasonic imaging similar to that of the CT scanner has been developed. However, reflections from tissue-to-air interfaces are so large that it is impossible to penetrate the lung. Ultrasonic waves scatter from bones and do not travel in straight lines within the body. Hence the reconstructed images have spatial distortion.

Impedance imaging is a technique that can form images of the body structures noninvasively and non-destructively. It utilizes the fact that voltages applied to regions of different conductivity conduct different currents. Taking these current measurements for many projection angles from body-surface electrodes, we can reconstruct impedance images of the body.

Advisor: Willis J. Tompkins, Ph.D.
Department of Electrical and Computer Engineering
University of Wisconsin
Madison, WI 53706

A NONLINEAR MODEL OF THE AUTOREGULATORY PROPERTY
OF THE CORONARY BLOOD FLOW

Ricardo G. Kortas
Department of Computer Science, Washington University
Plinio B. L. Castrucci
Department of Systems Science, Sao Paulo University, Brazil

A nonlinear mathematical model describing the basic hydraulic properties of the blood circulation and autoregulatory properties of the coronary blood flow (CBF(t)) was created, based on the energetic balance of the cardiac work and simulated on a digital computer. The model is a mixed one, part of it including instantaneous values of the variables and another part including median values. The results obtained from the computer simulation of partial and total obstruction of the CBF correlate reasonably with the results obtained experimentally and help to explain them.

Advisor: Jerome R. Cox, Jr.
Chairman, Department of Computer Science
Washington University
St. Louis, MO 63130

ATTENDING: A SYSTEM WHICH CRITIQUES
A PREOPERATIVE ANESTHETIC PLAN

Perry L. Miller, Ph.D., M.D.
Department of Anesthesiology, Yale School of Medicine

This paper describes ATTENDING, an Artificial Intelligence system under development, designed and implemented by the author, which critiques a preoperative anesthetic plan.

The ATTENDING system receives as input 1) a list of a patient's underlying problems, 2) a planned surgical procedure, and 3) a proposed anesthetic plan which specifies the techniques and agents to be used for premedication, induction, intubation, and maintenance of general anesthesia, or alternatively for a regional anesthetic technique. The system critiques this plan from the standpoint of the patient's underlying problems and their inherent risks. In so doing, it may ask further questions, suggest alternative approaches, and discuss the risks and benefits of different approaches for the patient described.

ATTENDING is designed with the philosophy that there are frequently several possible approaches to managing a given problem in medicine. A physician often has his own characteristic style and would likely not tolerate a system which did not allow him to practice in his accustomed fashion. Therefore, rather than advocate a particular approach, ATTENDING accommodates itself to the physician, and tailors its advice around his thinking and his proposed plan.

Advisor: Harry Wollman, M.D.
Department of Anesthesiology
University of Pennsylvania School of Medicine
Philadelphia, PA 19104

DESIGN, IMPLEMENTATION, AND EVALUATION OF
A MICROCOMPUTER-BASED PORTABLE ARRHYTHMIA MONITOR

Nitish V. Thakor, J. G. Webster, and W. J. Tompkins
Department of Electrical and Computer Engineering
University of Wisconsin

We describe the design of a portable, battery-operated microcomputer-based monitor for ambulatory ECG recording and analysis. Designed for realtime cardiac arrhythmia analysis, it is suitable for use on ambulatory patients for several weeks and is about the size and weight of a Holter monitor. Our device differs from a Holter monitor in that it does not store normal complexes but recognizes and alarms on significant arrhythmias. It stores 16-s of the arrhythmic event which it can transmit over telephone to a central receiving station for an immediate appraisal by a cardiologist. The device uses a CMOS microcomputer and has 2 kbytes of program memory and 2 kbytes of data memory. We have investigated an optimized QRS filtering and detection scheme for reliable QRS complex identification. The arrhythmia monitor program recognizes tachycardia, bradycardia, asystole, dropped beats, and PVC's. The alarm limits are physician programmable. We compare the performance of the QRS detector against three commercial systems with a database consisting of 10,000 beats. We further evaluate the performance of the arrhythmia monitor with standard annotated ECG tapes provided by MIT/BIH. This device should be useful in anti-arrhythmic drug studies, pacemaker and post-surgery evaluations, and for providing premonitory warning of myocardial infarcts or sudden death.

Advisor: John G. Webster, Ph.D.
Department of Electrical and Computer Engineering
University of Wisconsin
Madison, WI 53706

A GRAPHICS DISPLAY FOR LABORATORY PROFILES:
A MICROCOMPUTER APPLICATION TO ENHANCE
PHYSICIAN ASSIMILATION OF NUMERICAL DATA

John L. Zimmer, M.D.
Southwest Michigan Area Health Education Center

A graphics application originally developed on PLATO has been adapted to run on an Apple II microcomputer. It displays a laboratory profile in a radial array with each axis adjusted to a common size normal range. The resulting pattern is amenable to a rapid, non-mathematical mode of interpretation that reduces the calculation needed to interpret the profile and thus increases the efficiency of the physician's interaction with the data. Plans for future development and testing of the application are discussed along with the broader implications of graphics to medical computing.

Advisor: Lee Hamilton, M.D.
Southwest Michigan Area Health Education Center
Family Practice Residency
Kalamazoo, MI 49004